# MEMORANDUM

**To:** Melanie Magee, EPA Region 6
**CC:** Mike Holbrook, Texas Gulf Terminals LLC
Denise Rogers, Texas Gulf Terminals LLC
**From:** Brian Burdorf, Trinity Consultants
**Date:** May 14, 2019
**RE:** TGT Cost Effectiveness Analysis

## EXECUTIVE SUMMARY

Per EPA request, Texas Gulf Terminals LLC (TGT) has prepared an analysis of the costs to design, construct, and operate an emissions abatement system beyond submerged fill for the proposed SPM buoy system. TGT maintains that the control system recommended for this analysis (constructing an offshore platform with a vapor collection and vapor combustion unit) has not been demonstrated in practice and is not technically feasible for the proposed TGT crude oil export deepwater port SPM buoy system. The analysis further supports TGT's previous conclusion that submerged fill represents the appropriate case-by-case MACT limit for the proposed SPM buoy system. The estimated control cost effectiveness for VOC and HAP are in Table 1 below.

Table 1 – Cost Effectiveness Summary

| Pollutant | Approximate Total Annual Cost ($/year) | Pollutant Removed (tpy) | Approximate Cost per Ton of Pollutant Removed ($/ton) |
|---|---|---|---|
| VOC | $204 million | 10,165 tpy | $20,000/ton VOC |
| HAP | | 508 tpy | $400,000/ton HAP |

In addition to being undemonstrated in practice, applying additional controls beyond submerged fill for the TGT SPM buoy system is not economically feasible.

## 112(G) CASE BY CASE MACT ANALYSIS

TGT submitted a case-by-case MACT analysis under section 112(g) of the Clean Air Act. As part of the preamble to Section 112(g), the EPA provides several factors that may be considered when determining the level of control that is appropriate for a 112(g) case by case decision. Of particular importance to the cost calculation detailed in this memo is the following (emphasis added):

> *"The following factors **may** be considered: [...] the cost **and** effectiveness of controls for one source category relative to the cost **and** effectiveness of those controls for the other source category."*

The above statement does not specifically require performance of a cost analysis for a given application. Rather, the language provides items that *may* be considered when determining the appropriate controls to evaluate.

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Furthermore, the preamble language clarifies that if the cost of a control approach is considered, the effectiveness of that control methodology must also be taken into consideration. TGT has performed the following cost analysis taking into consideration the technical challenges and expected ineffectiveness for operations of a control scenario that has not been demonstrated in practice.

## CONTROL COST ANALYSIS

TGT prepared a cost analysis for the design, construction, and operation of an offshore platform with marine loading vapor collection and control equipment located near the proposed deepwater port SPM buoy system.

TGT followed EPA's Office of Air Quality Planning and Standards (OAQPS) guidance to annualize the cost for the control system.[1] The following items are examples of factors that can impact the capital and the annual operating costs:

- **Capital Costs**
  - Purchased equipment costs
    - Offshore platform for controls, helipad, subsea lines, VCU
    - Instrumentation
    - Freight
  - Direct installation costs
  - Engineering, design, construction services, contractor fees, start-up, performance tests
  - Lost revenue due to delay in project start
  - Permitting for co-located platform design
- **Annual Operating Costs**
  - Lost revenue from reduced annual operation
  - Platform supply / support vessels
  - Utilities
  - Salaries
  - Maintenance
  - Waste disposal
  - Compliance testing
  - Administrative charges, insurance, taxes

Given the uncertainty and first of its kind situation, reliable information is currently not readily available to accurately quantify what the hypothetical control system would cost to design, construct, and operate while accounting for the inherent technical and operating challenges associated with the control system. Actual costs could exceed TGT's estimates in this analysis. TGT's estimate for the capital cost of building the co-located platform and vapor collection and control system is provided in Attachment 1.

The capital costs included in the cost effectiveness calculations represent TGT's best estimate of the potential costs for constructing an adjacent platform and vapor collection and control system. Given the lack of a detailed engineering design for the control system and the lack of existing similar systems for which to pull cost data from, the estimate provided represents a study-level estimate at best. TGT accounted for as many major capital costs as reasonable given the available information. To account for the high degree of uncertainty, TGT applied a 30% contingency factor to the capital costs.

Marine loading vapor collection and control units are established technologies when located onshore or at a dock or pier connected to the shore but they have not been demonstrated in practice in the manner being evaluated here. There is no guarantee that this system would function effectively for the proposed SPM buoy system. To account for the uncertainty of operation, TGT has estimated the annual operating costs as the loss in revenue compared to the submerged fill scenario proposed as case-by-case MACT for this project. To estimate

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[1] https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution#cost%20manual

the revenue loss from the hypothetical scenario, TGT compared the currently proposed throughput to the reduction in throughput that would be required assuming the vapor collection and control system was not effective. In this case, the proposed annual VLCCs loaded would drop from 96 per year to approximately 5 per year (equivalent to an approximate 95% reduction in emissions). TGT's financial models predict a negative impact for the project of $138.8 million per year assuming reduced SPM operations due to vapor collection and control system complications (down time).

The total capital costs are multiplied by a capital recover factor (CRF) to derive the capital recovery on total capital investment. The CRF is calculated as follows:

$$CRF = \frac{i(1+i)^n}{(1+i)^n - 1}$$

Where $i$ is the annual interest rate and $n$ is the equipment life in years. Using an interest rate of 4.25% (default value in EPA Cost Control Spreadsheet for Thermal Oxiders, Jan, 2018) and an assumed equipment life of 15 years (IRS Publication 976 (2017) GDS for Asset Class 49.25) the results in a CRF of 0.0915. As mentioned, the CRF is multiplied by the total capital costs to derive the capital recovery on total capital investment. Estimates for annual administrative charges, property taxes, and insurance (at 2%, 1%, and 1%, respectively of the capital investment) are included in the annualized capital cost. The total annual cost of the potential control device is calculated as the sum of the annualized capital cost (indirect annual costs) and the annual operating costs (direct annual costs). The total annual control cost divided by the annual amount of pollutant controlled provides the estimated control cost effectiveness ($/ton).

$$Control\ Cost\ Effectiveness\ (\$/ton) = \frac{annualized\ capital\ cost + annual\ operating\ costs}{ton\ per\ year\ emission\ reduction}$$

For this analysis, a hypothetical (not demonstrated in practice) emission reduction for VOC and HAPs from a co-located platform with a vapor capture and control system is assumed to represent 95% control and 99% collection efficiency. As such, TGT based the cost effective analysis on an emissions reduction of 10,165 tpy VOC and 508.25 tpy HAP.[3] The resulting control cost effectiveness is calculated as such:

$$Control\ Cost\ Effectiveness\ \left(\frac{\$}{ton\ VOC}\right) = \frac{\$49{,}041{,}802 + \$154{,}995{,}000}{10{,}165\ tpy\ VOC} = \$20{,}073$$

$$Control\ Cost\ Effectiveness\ \left(\frac{\$}{ton\ HAP}\right) = \frac{\$49{,}041{,}802 + \$154{,}995{,}000}{508.25\ tpy\ HAP} = \$401{,}453$$

This analysis calculates a cost effectiveness as follows:

- $20,073 per ton of VOC removed
- $401.453 per ton of HAP removed

In addition to not being demonstrated in practice, additional controls beyond submerged fill are not economically feasible for the proposed TGT SPM buoy system.

[3] Based on the original DWP application potential to emit of 10,808 tpy VOC and an assumed HAP vapor composition of 5%.

# Attachment 1 - Cost Effectiveness Calculations

**TGT VCU and Offshore Platform Cost Estimate**

| Capital Cost | | Notation | Notes |
|---|---|---|---|
| *Purchased Equipment Costs* | | | |
| Equipment Cost | 24,991,000 | A | Includes cost of combustors, tanks, cranes, pumps/blowers, LACT unit, skids, and generators |
| Instrumentation | 7,497,300 | | TGT assumed 30% due to harsh environment and complex process in comparison to onshore equivalent. OAPQS manual Section 1 Chapter 2 (01/02) states range of 5% - 30%. |
| Freight | 2,499,100 | | TGT assumed 10% since unique offshore location. OAPQS manual Section 1 Chapter 2 (01/02) states range of 1% - 10%. |
| *Total Purchased Equipment Costs* | *34,987,400* | *B* | |
| *Direct Installation Costs* | | | |
| Offshore Platform | 104,950,000 | | Cost of Offshore VCU Platform |
| Set Jacket, Drive Piles, and Set Deck | 60,000,000 | | |
| Piping | 6,000,000 | | Piping from SPM to VCU deck |
| Hoses | 6,750,000 | | Hoses connecting VLCC to SPM |
| Pigging | 4,550,000 | | Launchers/Receivers and Pigs |
| Water System | 500,000 | | Water System for Living Quarters |
| Buildings | 4,550,000 | | Buildings for Living Quarters and Control Room |
| Communications | 1,200,000 | | Communication Systems |
| Site Preparation | 3,500,000 | | Geotech for pipeline, CALM, PLEM, and Platform |
| *Total Direct Installation Costs* | *192,000,000* | *C* | |
| *Total Direct Costs* | 226,987,400 | *D = B + C* | |
| *Indirect Installation Costs* | | | |
| Engineering and Design | 22,698,740 | 0.10*D | Based off of Total Direct installation Costs using same ratio (10%) as provided in OAQPS Section 3 Chapter 2 (11/17). Used Direct Installation Costs to ratio due to the increased complexity of offshore design. |
| Construction Services | 11,349,370 | 0.05*D | Based off of Total Direct installation Costs using same ratio (5%) as provided in OAQPS Section 3 Chapter 2 (11/17). Used Direct Installation Costs to ratio due to the increased complexity of offshore design. |
| Contractor Fees | 22,698,740 | 0.10*D | Based off of Total Direct installation Costs using same ratio (5%) as provided in OAQPS Section 3 Chapter 2 (11/17). Used Direct Installation Costs to ratio due to the increased complexity of offshore design. |
| Environmental | 1,000,000 | | Sampling, testing, and modeling. |
| Start-up | 1,399,496 | 0.04*B | Assumes double the OAQPS Ratio of 2% due to increased complexity of offshore location. |
| Performance Test | 699,748 | 0.02*B | Assumes double the OAQPS Ratio of 1% due to increased complexity of offshore location. |
| *Total Indirect Installation Costs* | *59,846,094* | *E* | |
| Project Contingency | 86,050,048 | *F* | 30% of Total Direct Costs and Total Indirect Costs. OAQPS Section 1 Chapter 2 (11/17) states contingency accounts for inadequacies in cost estimateing methods. This cost estimate is for a first-of-its-kind technology and therefore demands a high contingency factor. TGT selected 30% given project complexity, and that this is a Study level estimate with only basic information on the control technology design. |
| *Total Plant Cost* | *372,883,542* | ***TPC = D + E + F*** | |
| **Total Capital Investment** | **372,883,542** | **TCI** | |

| Operating Cost | | Notation | |
|---|---|---|---|
| *Direct Annual Costs* | | | |
| Operating and Supervisory Labor | 8,235,000 | | Annual labor costs including benefits. Assumes 1 offshore lead, 4 offshore operators, and 1 offshore HSE leader for each shift (5 total shifts). |
| Helicopter Flights to SPM | 1,460,000 | | Assumes 1 flight every 2 weeks for shift change. |
| Utilities - LPG, Nitrogen, Diesel, Food, Misc. | 5,000,000 | | |
| Supply Vessels for LPG, Nitrogen, Diesel, Food, Misc. | 1,500,000 | | |
| Annual Revenue Losses | 138,800,000 | | Negative financial impact on project due to reduction in SPM throughput (VLCC export) caused by vapor collection and control system complications. |
| *Total Direct Annual Costs* | *154,995,000* | ***DAC*** | |
| *Indirect Annual Costs* | | | |
| Administrative Charges | 7,457,671 | | Per EPA Cost Control Spreadsheet, January 2018 (2% of TCI) |
| Property Taxes | 3,728,835 | | Per EPA Cost Control Spreadsheet, January 2018 (1% of TCI) |
| Insurance | 3,728,835 | | Per EPA Cost Control Spreadsheet, January 2018 (1% of TCI) |
| Capital Recovery on Total Capital Investm | 34,126,460 | | Equation 2.8 from EPA Cost Manual, 7th Ed. (November 2017) |
| *Total Indirect Annual Costs* | *49,041,802* | ***IDAC*** | |
| **Total Annual Cost** | **204,036,802** | ***TAC = DAC + IDAC*** | |
| VOC Removed (tpy) | 10,165 | | |
| **Cost per ton of VOC Removed** | **20,073** | ***$/ton = TAC / Pollutant Removed*** | |
| HAP Removed (tpy) | 508.25 | | |
| **Cost per ton of HAP Removed** | **401,453** | ***$/ton = TAC / Pollutant Removed*** | |

**TGT VCU and Platform Cost Estimate Table 2 ($/ton)**

| Parameter | VCU | Units | Reference | Notes |
|---|---|---|---|---|
| Annual Average Heat Input Capacity | | MMBtu/hr | | |
| Uncontrolled Potential Emissions of VOC | | tpy | | |
| Annual Hours of Operation | | hrs/yr | | |
| Capture Efficiency | 99% | % | | |
| Removal Efficiency | 95% | % | | |
| Controlled Potential Emissions of VOC | - | tpy | | |
| Pollutant Removed | - | tpy | | |
| **VCU Requirements** | | | | |
| Cost Per Supply Ship Trip | | $ | | |
| Number of Supply Ship Trips Required | | Trips/yr | | LPG cost could be lumped into cost of supply ship trips or LPG needs could be used in determining the number of supply trips needed. |
| Amount of LPG Required | | gal/yr | | |
| VCU Booster Fan Electricity Demands | | kW | | Electricity requirement for vapor blower unit (generator if offshore) |
| Volumetric Flow Rate | | acfm | | Only needed if have to calculate electricity demand for booster fan |
| Pressure Drop | | "H2O | | Only needed if have to calculate electricity demand for booster fan |
| Motor Efficiency | | percent | | Only needed if have to calculate electricity demand for booster fan |
| VCU Generator Fuel Type | | | | If applicable (if booster fan powered by generator) |
| VCU Generator Engine Rating | | bhp | | If applicable (if booster fan powered by generator) |
| VCU Generator Engine Maximum Heat Input | | MMBtu/hr | | If applicable (if booster fan powered by generator) |
| VCU Generator Fuel Required | | gal | | If applicable (if booster fan powered by generator) |
| VCU Equipment Life | 15.00 | years | | IRS Publication 946 (2017) GDS for Asset Class 49.25 |
| Interest Rate | 4.3% | % | | Default value in EPA Cost Control Spreadsheet for Thermal Oxidizer (Jan. 2018) |
| CRF (15 Years) | 0.0915 | | | Equation 2.8a from EPA Cost Manual, 7th Ed. (November 2017) |